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NASA Contractor Report CR 168123

Documentation of Computer Program GRIDDEL

by K.J. Baumann

(NASA-CR-168123) DOCUMENTATION OF COMPUTER
PROGRAM GRIDDEL (Carnegie-Mellon Univ.)
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16. Abstract This report documents GRIDDEL, a computer program which generates finite element meshes for NASTRAN in a manner convenient to the study of laminated composite flat plates. It is capable of creating 8 node HEXA elements, GPID coordinates, and PSOLID data in the appropriate NASTRAN format. It is more convenient for this purpose than use of NASTRAN's preprocessors.					
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ABSTRACT

This report documents GRIDDEL, a computer program which generates finite element meshes for NASTRAN in a manner convenient to the study of laminated composite flat plates. It is capable of creating 8 node HEXA elements, GRID coordinates, and PSOLID data in the appropriate NASTRAN format. It is more convenient for this purpose than use of NASTRAN's preprocessors.

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SUMMARY

GRIDDEL is a short and simple computer program written specifically for convenience in generating finite elements and grid points appropriate for studying laminated composite flat plates on NASTRAN. It relieves the engineer from the tedious and time consuming use of NASTRAN's (for our purpose) awkward preprocessors. Grid points are generated in a sequence resulting in minimal bandwidth for common laminate geometries. Eight node HEXA elements, GRID coordinates, and PSOLID data are generated in formats appropriate for NASTRAN input. A minimal amount of input is required, and the origin of grid coordinates may be arbitrarily specified.

INTRODUCTION

Although NASTRAN features preprocessors capable of generating elements and meshes, they are found to be very awkward for studying laminated composite flat plates. GRIDDEL is written and documented since it may be of more general use in studies of laminated plates.

The desire to model graphite/epoxy plates of varying thicknesses, stacking sequences, lengths, widths, material properties, and mesh sizes led to this program's development. Far less input is required using GRIDDEL than would be using NASTRAN's preprocessors. For example, a 3D mesh of thousands of elements and grid points can be generated in a few minutes.

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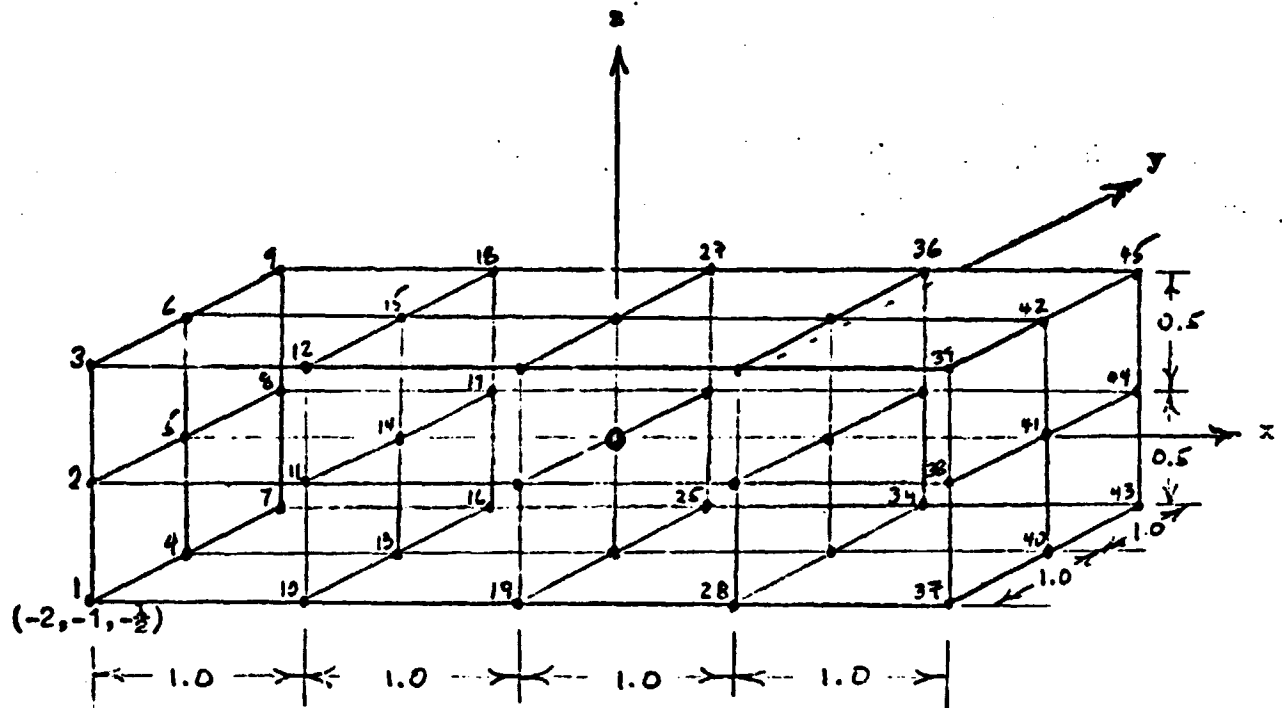
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CAPABILITIES

- 1) Generates 3D mesh of 8 node brick elements, grid points, and PSOLID data (CHEXA, GRID, and PSOLID NASTRAN data in NASTRAN input format).
- 2) Lamina material ids can be specified layer by layer in the z-direction.
- 3) Easy to change one or more lamina thickness, material id, length, width, mesh size.
- 4) Arbitrary origin coordinates.
- 5) Bandwidth is minimal for typical laminates being studied.
- 6) Variable element sizes easy to input.

LIMITATIONS

- 1) Presently capable only of 8 node brick elements.
- 2) Input appropriate for NASTRAN MCS version.
- 3) Size of mesh limited by dimension statements; currently 20 x 10 x 33 = 6600 elements in x,y,z directions.
- 4) Generates grid points and elements only in z,y,x sequence.
- 5) Elements (lamina) with the same PSOLID cards lie in xy planes.

SAMPLE PROBLEM 1 (simple test case)ORIGINAL PAGE IS
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	x	y	z
Origin coordinates	-2.0	-1.0	-0.5
Number of nodes	5	3	3
Number of elements	4	2	2
Node spacing	1.0	1.0	0.5
	1.0	1.0	0.5
	1.0		
	1.0		

INPUT:

```

-2.0  -1.0  -0.5
  4  2  2
  5  3  3
    1.0
    1.0
    1.0
    1.0
    1.0
    1.0
    0.5
    0.5
321
  1
  1

```

OUTPUT

(simple test case)

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GRID	1	-2.00000-1.00000-0.50000
GRID	2	-2.00000-1.00000 0.00000
GRID	3	-2.00000-1.00000 0.50000
GRID	4	-2.00000 0.00000-0.50000
GRID	5	-2.00000 0.00000 0.00000
GRID	6	-2.00000 0.00000 0.50000
GRID	7	-2.00000 1.00000-0.50000
GRID	8	-2.00000 1.00000 0.00000
GRID	9	-2.00000 1.00000 0.50000
GRID	10	-1.00000-1.00000-0.50000
GRID	11	-1.00000-1.00000 0.00000
GRID	12	-1.00000-1.00000 0.50000
GRID	13	-1.00000 0.00000-0.50000
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GRID	15	-1.00000 0.00000 0.50000
GRID	16	-1.00000 1.00000-0.50000
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GRID	18	-1.00000 1.00000 0.50000
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GRID	35	1.00000 1.00000 0.00000
GRID	36	1.00000 1.00000 0.50000
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GRID	38	2.00000-1.00000 0.00000
GRID	39	2.00000-1.00000 0.50000
GRID	40	2.00000 0.00000-0.50000
GRID	41	2.00000 0.00000 0.00000
GRID	42	2.00000 0.00000 0.50000
GRID	43	2.00000 1.00000-0.50000
GRID	44	2.00000 1.00000 0.00000
GRID	45	2.00000 1.00000 0.50000

CHEXA	1	1	1	10	13	4	2	11AC	1		
+C	1	14	5	2	11	14	5	3	12AC	2	
CHEXA	2	15	6	3	4	13	16	7	5	14AC	3
+C	3	17	8	4	5	14	17	8	6	15AC	4
CHEXA	4	18	9	5	10	19	22	13	11	20AC	5
+C	5	23	14	6	11	20	23	14	12	21AC	6
CHEXA	6	24	15	7	13	22	25	16	14	23AC	7
+C	7	26	17	8	14	23	26	17	15	24AC	8
CHEXA	8	27	18	9	19	28	31	22	20	29AC	9
+C	9	32	23	10	20	29	32	23	21	30AC	10
CHEXA	10	33	24	11	22	31	34	25	23	32AC	11
+C	11	35	26	12	23	32	35	26	24	33AC	12
CHEXA	12	36	27	13	24	33	36	27	25	34AC	13
+C	13	37	28	14	25	34	37	28	26	35AC	14
CHEXA	14	38	29	15	26	35	38	29	27	36AC	15
+C	15	39	30	16	27	36	39	30	28	37AC	16
CHEXA	16	40	31	17	28	37	40	31	29	38AC	17
+C	17	41	32	18	29	38	41	32	30	39AC	18
CHEXA	18	42	33	19	30	39	42	33	31	40AC	19
+C	19	43	34	20	31	40	43	34	32	41AC	20
CHEXA	20	44	35	21	32	41	44	35	33	42AC	21
+C	21	45	36	22	33	42	45	36	34	43AC	22
CHEXA	22	46	37	23	34	43	46	37	35	44AC	23
+C	23	47	38	24	35	44	47	38	36	45AC	24
CHEXA	24	48	39	25	36	45	48	39	37	46AC	25
+C	25	49	40	26	37	46	49	40	38	47AC	26
CHEXA	26	50	41	27	38	47	50	41	39	48AC	27
+C	27	51	42	28	39	48	51	42	40	49AC	28
CHEXA	28	52	43	29	40	49	52	43	41	50AC	29
+C	29	53	44	30	41	50	53	44	42	51AC	30
CHEXA	30	54	45	31	42	51	54	45	43	52AC	31
+C	31	55	46	32	43	52	55	46	44	53AC	32
CHEXA	32	56	47	33	44	53	56	47	45	54AC	33
+C	33	57	48	34	45	54	57	48	46	55AC	34
CHEXA	34	58	49	35	46	55	58	49	47	56AC	35
+C	35	59	50	36	47	56	59	50	48	57AC	36
CHEXA	36	60	51	37	48	57	60	51	49	58AC	37
+C	37	61	52	38	49	58	61	52	50	59AC	38
CHEXA	38	62	53	39	50	59	62	53	51	60AC	39
+C	39	63	54	40	51	60	63	54	52	61AC	40
CHEXA	40	64	55	41	52	61	64	55	53	62AC	41
+C	41	65	56	42	53	62	65	56	54	63AC	42
CHEXA	42	66	57	43	54	63	66	57	55	64AC	43
+C	43	67	58	44	55	64	67	58	56	65AC	44
CHEXA	44	68	59	45	56	65	68	59	57	66AC	45
+C	45	69	60	46	57	66	69	60	58	67AC	46
CHEXA	46	70	61	47	58	67	70	61	59	68AC	47
+C	47	71	62	48	59	68	71	62	60	69AC	48
CHEXA	48	72	63	49	60	69	72	63	61	70AC	49
+C	49	73	64	50	61	70	73	64	62	71AC	50
CHEXA	50	74	65	51	62	71	74	65	63	72AC	51
+C	51	75	66	52	63	72	75	66	64	73AC	52
CHEXA	52	76	67	53	64	73	76	67	65	74AC	53
+C	53	77	68	54	65	74	77	68	66	75AC	54
CHEXA	54	78	69	55	66	75	78	69	67	76AC	55
+C	55	79	70	56	67	76	79	70	68	77AC	56
CHEXA	56	80	71	57	68	77	80	71	69	78AC	57
+C	57	81	72	58	69	78	81	72	70	79AC	58
CHEXA	58	82	73	59	70	79	82	73	71	80AC	59
+C	59	83	74	60	71	80	83	74	72	81AC	60
CHEXA	60	84	75	61	72	81	84	75	73	82AC	61
+C	61	85	76	62	73	82	85	76	74	83AC	62
CHEXA	62	86	77	63	74	83	86	77	75	84AC	63
+C	63	87	78	64	75	84	87	78	76	85AC	64
CHEXA	64	88	79	65	76	85	88	79	77	86AC	65
+C	65	89	80	66	77	86	89	80	78	87AC	66
CHEXA	66	90	81	67	78	87	90	81	79	88AC	67
+C	67	91	82	68	79	88	91	82	80	89AC	68
CHEXA	68	92	83	69	80	89	92	83	81	90AC	69
+C	69	93	84	70	81	90	93	84	82	91AC	70
CHEXA	70	94	85	71	82	91	94	85	83	92AC	71
+C	71	95	86	72	83	92	95	86	84	93AC	72
CHEXA	72	96	87	73	84	93	96	87	85	94AC	73
+C	73	97	88	74	85	94	97	88	86	95AC	74
CHEXA	74	98	89	75	86	95	98	89	87	96AC	75
+C	75	99	90	76	87	96	99	90	88	97AC	76
CHEXA	76	100	91	77	88	97	100	91	89	98AC	77
+C	77	101	92	78	89	98	101	92	90	99AC	78
CHEXA	78	102	93	79	90	99	102	93	91	100AC	79
+C	79	103	94	80	91	100	103	94	92	101AC	80
CHEXA	80	104	95	81	92	101	104	95	93	102AC	81
+C	81	105	96	82	93	102	105	96	94	103AC	82
CHEXA	82	106	97	83	94	103	106	97	95	104AC	83
+C	83	107	98	84	95	104	107	98	96	105AC	84
CHEXA	84	108	99	85	96	105	108	99	97	106AC	85
+C	85	109	100	86	97	106	109	100	98	107AC	86
CHEXA	86	110	101	87	98	107	110	101	99	108AC	87
+C	87	111	102	88	99	108	111	102	100	109AC	88
CHEXA	88	112	103	89	100	109	112	103	101	110AC	89
+C	89	113	104	90	101	110	113	104	102	111AC	90
CHEXA	90	114	105	91	102	111	114	105	103	112AC	91
+C	91	115	106	92	103	112	115	106	104	113AC	92
CHEXA	92	116	107	93	104	113	116	107	105	114AC	93
+C	93	117	108	94	105	114	117	108	106	115AC	94
CHEXA	94	118	109	95	106	115	118	109	107	116AC	95
+C	95	119	110	96	107	116	119	110	108	117AC	96
CHEXA	96	120	111	97	108	117	120	111	109	118AC	97
+C	97	121	112	98	109	118	121	112	110	119AC	98
CHEXA	98	122	113	99	110	119	122	113	111	120AC	99
+C	99	123	114	100	111	120	123	114	112	121AC	100
CHEXA	100	124	115	101	112	121	124	115	113	122AC	101
+C	101	125	116	102	113	122	125	116	114	123AC	102
CHEXA	102	126	117	103	114	123	126	117	115	124AC	103
+C	103	127	118	104	115	124	127	118	116	125AC	104
CHEXA	104	128	119	105	116	125	128	119	117	126AC	105
+C	105	129	120	106	117	126	129	120	118	127AC	106
CHEXA	106	130	121	107	118	127	130	121	119	128AC	107
+C	107	131	122	108	119	128	131	122	120	129AC	108
CHEXA	108	132	123	109	120	129	132	123	121	130AC	109
+C	109	133	124	110	121	130	133	124	122	131AC	110
CHEXA	110	134	125	111	122	131	134				

OUTPUT cont'd. (simple test case)

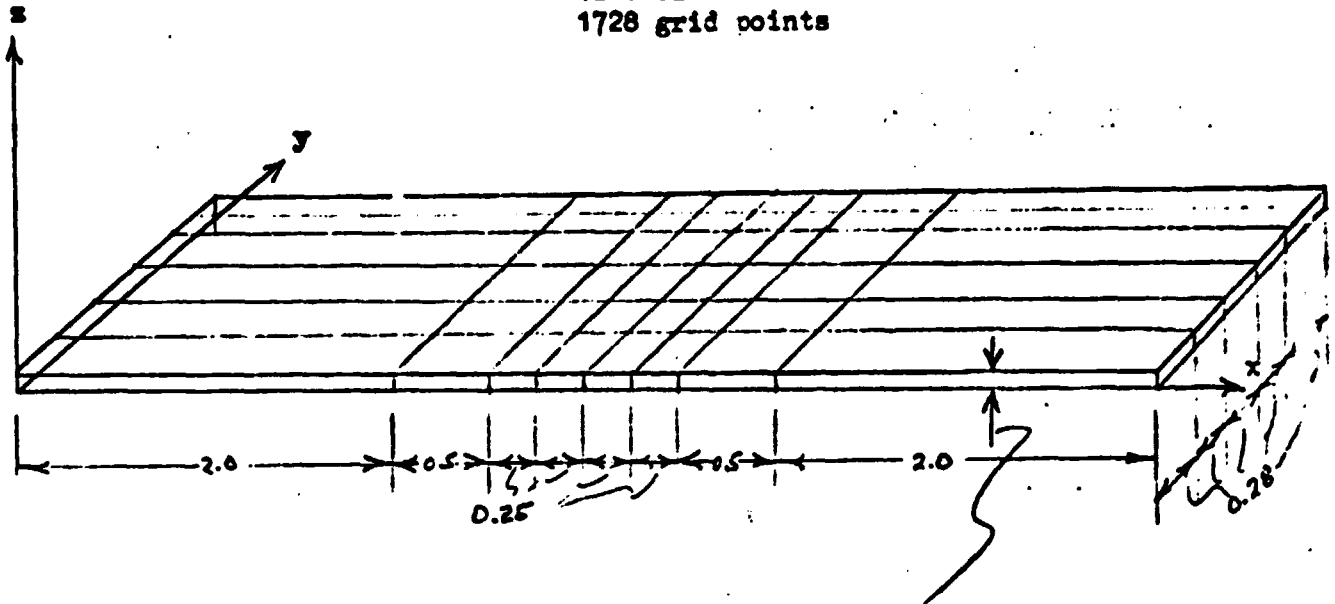
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+C	13	41	32							
CHEXA		14	14	29	38	41	32	30	39AC	14
+C	14	42	33							
CHEXA		15	15	31	40	43	34	32	41AC	15
+C	15	44	35							
CHEXA		16	16	32	41	44	35	33	42AC	16
+C	16	45	36							
PSOLID		1	1							
PSOLID		2	1							
PSOLID		3	1							
PSOLID		4	1							
PSOLID		5	1							
PSOLID		6	1							
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PSOLID		8	1							
PSOLID		9	1							
PSOLID		10	1							
PSOLID		11	1							
PSOLID		12	1							
PSOLID		13	1							
PSOLID		14	1							
PSOLID		15	1							
PSOLID		16	1							

SAMPLE PROBLEM: 2 {Quasi-isotropic Graphite/Epoxy 16 layer plate}
(stacking sequence $(0/+45/90/-45/-45/90/+45/0)_8$)

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1240 elements
1728 grid points



0.0795 thickness in z-direction
32 nodes, 31 elements in z-direction
(not shown) representing 15 Gr/E plies (each 0.0045)
and 15 Epoxy interplies (each 0.0005)

INPUT:

[illegible]

INPUT cont'd. (sample problem 2)

0.0005
 0.0045
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PROGRAM LISTING

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C00200 C THIS PROGRAM GENERATES 3D CARTESIAN GRID POINTS AND ELEMENTS
C00230 C FOR NASTRAN & NODE REGULAR BRICK ELEMENTS
C00300 C DIMENSION DELT(20),DELT(10),DELT(33),LAWID(33),NODENO(21,11,3-
C00350 C 4),X(21,11,34),Y(21,11,34),Z(21,11,34),DX(20),DY(10),DZ(33),IELNO-
C00400 C (21,11,34),IGI(21,11,34),IG2(21,11,34),IG3(21,11,34),IG4(1,11,34-
C00450 C ),IG5(21,11,34),IG6(21,11,34),IG7(21,11,34),IG8(21,11,34),IELNID(-
C00500 C 21,11,34)
C00520 C NODENO IS GRID POINT NUMBER
C00550 C NEXT CARD READS COORDS OF ARBITRARY ORIGIN
C00600 C READ(5,10)XSTPT,YSTPT,ZSTPT
C00630 C 10 FORMAT(3F8.5)
C00660 C NEXT CARD READS NUMBER OF ELEMENTS IN X,Y,Z DIRECTIONS
C00700 C READ(5,20)NOELX,NOELY,NOELZ
C00730 C 20 FORMAT(3I3)
C00760 C NEXT CARD READS NUMBER OF NODES IN X,Y,Z DIRECTIONS
C00800 C READ(5,25)NONODX,NONODY,NONODZ
C00830 C 25 FORMAT(3I3)
C00860 C NEXT GROUP OF CARDS READS NODE SPACINGS IN X,Y, AND Z DIRECTIONS
C00900 C DO 30 I=1,NOELX,1
C00930 C 30 READ(5,40)DELT(I)
C00960 C 40 FORMAT(F10.3)
C00990 C DO 50 I=1,NOELY
C01020 C 50 READ(5,40)DELT(I)
C01050 C DO 60 I=1,NOELZ
C01080 C 60 READ(5,40)DELT(I)
C01110 C ONLY THE OPTION 321=KEYGEN IS CURRENTLY PROGRAMMED
C01140 C KEYGEN=123 GENERATES NODES IN ORDER X,Y,Z; 213 GIVES Y,X,Z, ETC.
C01170 C READ(5,70)KEYGEN
C01200 C 70 FORMAT(I3)
C01230 C THE NEXT CARD READS THE MATERIAL I.D. (MID)
C01260 C OF EACH LAMINA OF ELEMENTS IN THE XY PLANE STARTING AT THE
C01290 C Z ORIGIN AND PROGRESSING SEQUENTIALLY IN THE +Z DIRECTION
C01320 C DO 100 K=1,NOELZ
C01350 C READ(5,90)LAWID(K)
C01380 C 90 FORMAT(I8)
C01410 C 100 CONTINUE
C01440 C THE FOLLOWING GENERATES A LINE OF NONODZ NODE NUMBERS IN THE
C01470 C Z DIRECTION, THEN REPEATS IT NONODY TIMES IN Y DIRECTION, AND
C01500 C REPEATS ALL THAT IN THE Z DIRECTION. THERE ARE 3 LEFT HAND
C01530 C (132,213, AND 321) AND 3 RIGHT HAND SYSTEMS (123, 231,
C01560 C AND 312) WHICH COULD BE PROGRAMMED.
C01590 C DO 1000 I=1,NONODX
C01620 C DO 1000 J=1,NONODY
C01650 C DO 1000 K=1,NONODZ
C01680 C NODENO(I,J,K)=NONODZ*(J-1)+K+NONODX*NONODY*(I-1)
C01710 C 1000 CONTINUE
C01740 C THE FOLLOWING GENERATES DISTANCES FROM THE START POINT FOR
C01770 C EACH NODAL PLANE
C01800 C X(1,1,1)=XSTPT
C01830 C Y(1,1,1)=YSTPT
C01860 C Z(1,1,1)=ZSTPT
C01890 C DUNITX=0.0
C01920 C DUNITY=0.0
C01950 C DUNITZ=0.0

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0003300 DO 4000 I=1,NOELX
0003400 DX(I+1)=DELTX(I)+DUMX
0003500 DUMX=DUMX +DELTX(I)
0003600 CONTINUE
0003700 4000 DO 4010 I=1,NOELY
0003800 DY(I+1)=DELY(I) + DUMY
0003900 DUMY=DUMY + DELY(I)
0004000 CONTINUE
0004100 4010 DO 4020 I=1,NOELZ
0004200 DZ(I+1)=DELZ(I)+DUMZ
0004300 DUMZ= DUMZ+DELZ(I)
0004400 CONTINUE
0004500 4020 THE FOLLOWING GENERATES GRID POINT COORDINATES
0004600 DX(1)=0.0
0004700 DY(1)=0.0
0004800 DZ(1)=0.0
0004900 DO 5000 I=1,NONODX
0005000 J=1,NOHODY
0005100 DO 4980 K=1,NOHODZ
0005200 X(I,J,K)=X(1,1,1)+DX(I)
0005300 Y(I,J,K)=Y(1,1,1) + DY(J)
0005400 Z(I,J,K)= Z(1,1,1) + DZ(K)
0005500 CONTINUE
0005600 4980 CONTINUE
0005700 5000 CONTINUE
0005800 THE PREVIOUS PART OF THE PROGRAM HAS GENERATED GRID POINT
0005900 NUMBERS, AND GRID POINT COORDINATES. THE FOLLOWING WILL
0006000 GENERATE ELEMENTS CONNECTING THESE GRID POINTS. ELEMENT
0006100 NUMBERS WILL BE GENERATED (ARBITRARILY) USING THE SAME
0006200 DIRECTIONALITY SCHEME AS THE GRID POINTS, EVEN THOUGH
0006300 BAKENWIDTH IS RELATED TO GRID NUMBERING AND NOT ELEMENT NUMBERING.
0006400 DO 6000 I=1,NOELX
0006500 J=1,NOELY
0006600 DO 5980 K=1,HOELZ
0006700 IELN(I,J,K)=(NOELZ*(J-1))+K+(NOELZ*NOELY*(I-1))
0006800 IG1(I,J,K)=NODENO(I,J,K)
0006900 IG2(I,J,K)=NODENO(I+1,J,K)
0007000 IG3(I,J,K)=NODENO(I+1,J+1,K)
0007100 IG4(I,J,K)=NODENO(I,J+1,K)
0007200 IG5(I,J,K)=NODENO(I,J,K+1)
0007300 IG6(I,J,K)=NODENO(I+1,J,K+1)
0007400 IG7(I,J,K)=NODENO(I+1,J+1,K+1)
0007500 IG8(I,J,K)=NODENO(I,J+1,K+1)
0007600 IELMID(I,J,K)=I+J+K
0007700 CONTINUE
0007800 5980 CONTINUE
0007900 5990 CONTINUE
0008000 6000 THE FOLLOWING PRINTS OUT THE DATA READ IN
0008100 WRITE(6,7000)XS IPT,YS IPT,ZS IPT
0008200 C FORMAT(' ',3F8.5)
0008300 7000 WRITE(6,7010)NOELX,NOELY,NOELZ
0008400 FORMAT(' ',3I3)
0008500 7010 FORMAT(' ',3I3)
0008600 WRITE(6,7020)NONODX,NOHODY,NOHODZ
0008700 7020 FORMAT(' ',3I3)
0008800

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0008900 DO 7030 I=1,NOELX
0009000 WRITE(6,7040)DELTX(I)
0009100 FORMAT(' ',F10.5)
0009200 DO 7050 J=1,NOELY
0009300 WRITE(6,7040)DELTJ(J)
0009400 DO 7060 K=1,NOELZ
0009500 WRITE(6,7040)DELTZ(K)
0009600 WRITE(6,7070)KEYGEN
0009700 FORMAT(' ',I3)
0009800 DO 7075 I=1,NOELZ
0009910 WRITE(6,7030) LAMMID(I)
0009920 FORMAT(' ',I3)
0009930 WRITE(6,7090)
0009940 C
0009950 THE FOLLOWING PRINTS THE CALCULATED OUTPUT
0009960 DO 8000 I=1,NOHODX
0009970 DO 7995 J=1,NOHODY
0009980 DO 7990 K=1,NOHODZ
0009990 WRITE(6,7980)HODENO(I,J,K),X(I,J,K),Y(I,J,K),Z(I,J,K)
0010000 FORMAT('GRID',4X,18.8X,3F8.5)
0010010 7980
0010020 7990 CONTINUE
0010030 7995 CONTINUE
0010040 8000 CONTINUE
0010050 DO 8100 I=1,NOELX
0010060 DO 8100 J=1,NOELY
0010070 DO 8100 K=1,NOELZ
0010080 WRITE(6,8050)IELNO(I,J,K),IELNO(I,J,K),IG1(I,J,K),IG2(I,J,K),IG3(-
0010090 C I,J,K),IG4(I,J,K),IG5(I,J,K),IG6(I,J,K),IELNO(I,J,K)
0010100 8050 FORMAT('CHEXA',3X,818,'AC',I6)
0010110 WRITE(6,8060)IELNO(I,J,K),IG7(I,J,K),IG8(I,J,K)
0010120 8060 FORMAT('C',I6,218)
0010130 8100 CONTINUE
0010140 DO 8200 I=1,NOELX
0010150 DO 8200 J=1,NOELY
0010160 DO 8200 K=1,NOELZ
0010170 WRITE(6,8150)IELNO(I,J,K),IELMID(I,J,K)
0010180 8150 FORMAT('PSOLID',2X,218)
0010190 8200 CONTINUE
0010200 STOP
0010210 END
0010220

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